1   1. A method of making a watermarked digital representation of a signal from an original

2   digital representation thereof,

3   the method comprising the steps of:

4   making a first transformation of the original digital representation;

5   adding watermark information to the first transformation; and

6   reversing the first transformation, the first transformation having the property that

7   making and reversing the transformation spreads the watermark information across the

8   original digital representation.

1   2. The method set forth in claim 1 wherein:

2   the original digital representation and the watermarked digital representation

3   belong to a first domain which is either the time/space domain or the frequency domain;

4   and

5   the step of making the first transformation includes the step of making a second

6   transformation into a second domain which is the opposite of the first domain and

7   the step of reversing the first transformation includes the step of making a third

8   transformation into the second domain.

1   3. The method set forth in claim 2 wherein:

2   in the step of making the first transformation, the step of making the second

3   transformation further includes the steps of

4   randomizing the second transformation and

5   obtaining the first transformation by transforming the randomized second

6   transformation into the first domain; and

7   in the step of reversing the first transformation, the step of making the third

8   transformation includes the steps of

9   obtaining the third transformation by transforming the watermarked first

10   transformation into the second domain;

11   derandomizing the third transformation; and

12   obtaining the watermarked digital representation by transforming the

13   derandomized third transformation into the first domain.

1   4. The method set forth in claim 3 wherein:

2   in the steps of randomizing and derandomizing, the randomizing and

3   derandomizing is done using a key.

1   5. The method set forth in claim 1 wherein the original digital representation has been

2   made according to a perception model and

3   the method further comprises the step of:

4   filtering the watermarked digital representation according to the perception

5   model.

1   6. The method set forth in claim 5 further comprising the steps of:

2   determining whether the watermarked digital representation conforms to a quality

3   and bitrate standard; and

4   when the watermarked digital representation does not conform, modifying the

5   watermarked digital representation according to the perception model.

1   7. The method set forth in claim 1 wherein:

2   the steps of the method are performed at the time the original digital

3   representation is made from a received digital representation.

1   8. A method of detecting watermark information in a watermarked digital representation

2   of a signal, the watermarked digital representation having been made from an original

3   digital representation of the signal by making a first transformation of the original digital

4   representation to produce a first intermediate digital representation, adding the watermark

5   information to the first intermediate digital representation, and making the watermarked

6   digital representation from the watermarked first intermediate digital representation by

7   reversing the first transformation and

8   the method comprising the steps of:

9   repeating the first transformation on the watermarked digital representation to

10   produce a second intermediate representation; and

11   determining whether the second intermediate digital representation contains the

12 watermark information.

1   9. A watermarked digital representation of a signal comprising:

2   a digital representation of the signal in either a first domain which is the

3   time/space domain or a second domain which is the frequency domain; and

4   watermark information spread across the digital representation, a transformation

5   between the domains and a reversal thereof having operated to spread the watermark

6   information.

1   10. A method of adding watermark information to a MPEG audio frame,

2   the method being performed after the raw samples for the MPEG audio frame have been

3   submitted to quantization according to an audio perception model to produce the MPEG

4   audio frame and before the MPEG audio frame is tested for conformance to a

5   predetermined bit rate and quality and the method comprising the steps of:

6   receiving the watermark information; and

7   adding the watermark information to the MPEG audio frame.

1   11. The method set forth in claim 10 further comprising the step performed when a

2   watermarked MPEG audio frame does not conform to the predetermined bit rate and

3   quality of:

4   submitting the watermarked MPEG audio frame to bit/noise allocation and

5   quantization.

1   12. The method set forth in claim 10 further comprising the step of:

2   filtering the watermarked MPEG audio frame with a filter based on the audio

3   perception model.

1   13. The method set forth in claim 10 wherein:

2   the step of adding the watermark information to the MPEG audio frame further

3   spreads the watermark information across the watermarked MPEG audio frame.

1   14. The method set forth in claim 13 further comprising the step performed when a
2   watermarked MPEG audio frame does not conform to the predetermined bit rate and
3   quality of:
4   submitting the watermarked MPEG audio frame to bit/noise allocation and
5   quantization.

1   15. The method set forth in claim 13 further comprising the step of:
2   filtering the watermarked MPEG audio frame with a filter based on the audio
3   perception model.

1   16. The method set forth in claim 13 wherein the step of adding the watermark
2   information to the MPEG audio frame further comprises the steps of:
3   making a transformed frame that is a reversible transformation of the MPEG
4   audio frame;
5   adding the watermark information to the transformed frame; and
6   making the watermarked MPEG audio frame by reversing the transformation of
7   the watermarked transformed frame,
8   the transformation and reversal thereof operating to spread the watermark information
9   across the watermarked MPEG audio frame.

1   17: The method set forth in claim 16 further comprising the step performed when a
2   watermarked MPEG audio frame does not conform to the predetermined bit rate and
3   quality of:
4   submitting the watermarked MPEG audio frame to bit/noise allocation and
5   quantization.

1   18. The method set forth in claim 16 further comprising the step of:
2   filtering the watermarked MPEG audio frame with a filter based on the audio
3   perception model.

1   19. The method set forth in claim 16 wherein:

2   the step of making the transformed frame further comprises the steps of

3   making a first transformation of the MPEG audio frame to the time

4   domain;

5   randomizing the first transformation; and

6   making a second transformation of the randomized first transformation to

7   the frequency domain; and

8   the step of reversing the transformation of the watermarked transformed frame

9   further comprises the steps of

10   making a third transformation of the watermarked second transformation

11   to the time domain;

12   derandomizing the third transformation; and

13   making a fourth transformation of the derandomized third transformation

14   to the frequency domain.

1   **20.** The method set forth in claim 19 wherein:

2   the step of adding the watermark information to the transformed frame comprises

3   the step of:

4   adding a predetermined frequency to the second transformation.

1   .21. The method set forth in claim 20 wherein:

2   the predetermined frequency represents a bit of the watermark information.

1   **22.** The method set forth in claim 19 wherein:

2   ·   in the steps of randomizing the first transformation and derandomizing the third

3   transformation, the randomizing and derandomizing are done using a key.

1   **23.** A method of detecting watermark information in a MPEG frame, the watermark

2   information having been added to the MPEG audio frame by making a transformed frame

3   that is a reversible transformation of the MPEG audio frame, adding the watermark

4   information to the transformed frame, and making the watermarked MPEG audio frame

5   by reversing the transformation of the watermarked transformed frame, and

6   the method comprising the steps of:

7   reversing the transformation of the watermarked transformed frame; and

8   determining whether the frame resulting therefrom contains watermark

9   information.

1   **24.** A method of adding watermark information to a MPEG audio frame comprising the

2   steps of:

3   making a transformed frame that is a reversible transformation of the audio frame;

4   adding the watermark information to the transformed frame; and

5   making a watermarked MPEG audio frame by reversing the transformation of the

6   watermarked transformed frame,

7   the transformation and reversal thereof operating to spread the watermark information

8   across the watermarked MPEG audio frame.

1   **25.** A MPEG audio frame comprising:

2   a frequency-domain representation of an audio signal; and

3   watermark information spread across the frequency-domain representation, a

4   transformation of the frequency-domain representation and a reversal thereof having

5   operated to spread the watermark information.

1   **26.** An improved MPEG audio encoder of the type that includes at least a quantizer that

2   produces an MPEG audio frame according to an audio perception model from raw

3   samples for the frame and a quality checker that receives the MPEG audio frame from the

4   quantizer, determines the quality and bitrate of the MPEG audio frame, and returns the

5   MPEG audio frame to the quantizer if the quality or bitrate is insufficient,

6   the improved MPEG audio encoder having the improvement comprising:

7   a watermarked frame maker that receives a MPEG audio frame from the

8   quantizer, adds watermark information to the MPEG audio frame, and provides the

9   watermarked MPEG audio frame to the quality checker.

1   **27.** An improved MPEG audio decoder of the type that receives a MPEG audio frame
2   and produces digital audio output therefrom,
3   the improved MPEG audio decoder having the improvement comprising:
4   a watermark information detector that detects watermark information in the
5   MPEG audio frame, the watermark information having been added to the MPEG audio
6   frame by making a transformed frame that is a reversible transformation of the MPEG
7   audio frame, adding the watermark information to the transformed frame, and making the
8   watermarked MPEG audio frame by reversing the transformation of the watermarked
9   transformed frame, and the watermark detector detecting the watermark information by
10   reversing the transformation of the watermarked transformed frame and determining
11   whether the frame resulting therefrom contains watermark information.

1   **28.** Apparatus for reading watermark information from a MPEG audio frame
2   comprising:
3   a watermark information detector that detects watermark information in the
4   MPEG audio frame, the watermark information having been added to the MPEG audio
5   frame by making a transformed frame that is a reversible transformation of the MPEG
6   audio frame, adding the watermark information to the transformed frame, and making the
7   watermarked MPEG audio frame by reversing the transformation of the watermarked
8   transformed frame, and the watermark detector detecting the watermark information by
9   reversing the transformation of the watermarked transformed frame and determining
10   whether the frame resulting therefrom contains watermark information; and
11   a watermark reader that receives the watermark information from the watermark
12   information detector and reads a watermark message from the watermark information.